BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

#5

Certification 040

8-20-01

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of GABZDYL.
S/N: 09/844,186
Filed: April 27, 2001
For: "Improvements in Thermal Welding"
Atty. Dkt.: M00B107

Group: 1725

Assistant Commissioner for Patents
Washington, DC 20231

TRANSMITTAL OF CERTIFIED COPY

Attached please find the certified copy of the foreign application from which priority is claimed for the subject patent application.

Country:	United Kingdom
Application No.:	0010793.8
Filing Date:	May 3, 2000

Respectfully submitted,

The BOC Group, Inc.
Intellectual Property Dept.
100 Mountain Ave.
Murray Hill, NJ 07974

Philip H. Von Neida
Attorney for Applicant(s)
Regn. No. 34,942
Tel. (908) 771-6402

CERTIFICATE OF MAILING (37 CFR 1.8)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington DC 20231.

Signature of Person Mailing Paper: Betty Lee Date: July 26, 2001
Print Name of Person Mailing Paper: Betty Lee

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS
The Patent Office

INVESTOR IN PEOPLE

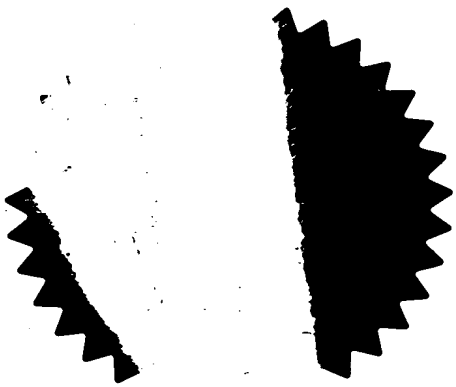
The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



Signed R. Mahoney

Dated 01 MAY 2001

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
03 MAY 2000
LONDON

The Patent Office

1/77

05MAY00 E534360-1 D02805
P01/7700 0.00-0010793.8

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — M00B107/RJB — **0010793.8**

03 MAY 2000

2. Patent application number
(The Patent Office will fill in this part)

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* **884627002**

If the applicant is a corporate body, give the country/state of its incorporation — England

4. Title of the invention — Improvements in Thermal Welding

5. Name of your agent *(if you have one)* — Roger James Bousfield

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* **973131002**

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	3
Claim(s)	1
Abstract	0
Drawing(s)	1+1/2

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

Signature R J Bousfield Date 2 May 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

Roger Bousfield
(01276) 477612

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

IMPROVEMENTS IN THERMAL WELDING

The present invention relates to thermal welding processes and in particular to methods of cooling work pieces during a thermal welding process.

During the thermal welding of metallic work pieces a high heat input is required to generate an acceptable weld. However, this high heat input has the disadvantage that it can cause significant levels of distortion of the work pieces being welded.

It is known to use gases to provide forced cooling during thermal welding processes. However, the results of using cooling gases are limited as the cooling ability of the gas streams is relatively low.

It is an aim of the present invention to utilise a jet of a cryogenic liquid or cryogenic solid to cool a thermal welding process.

According to the present invention a method of thermal welding together at least two metallic work pieces comprises the steps of applying heat at a welding zone for welding together the two work pieces; and applying at or adjacent the welding zone at least one jet of a cryogen.

The cryogen may be in the form of a liquid cryogen, for example, liquid nitrogen or liquid argon. Alternatively, the cryogen may be solid carbon dioxide.

Preferably the cryogen is applied to the welding zone through a plurality of nozzles.

Embodiments of the invention will now be described, by way of example, reference being made to the Figures of the accompanying diagrammatic drawings in which:

Figure 1 is a sketch of two metallic plates being butt welded together according to the present invention; and

Figure 2 is a sketch showing two metallic plates being fillet welded together according to the present invention.

Referring first to Figure 1, two metallic plates 1, 2 to be butt welded together are placed as shown side by side and a thermal welding torch 4 is positioned at the abutting surfaces of the two plates. The torch is energised in a manner known per se and heat is applied to the welding zone along the abutment of the two metal plates. At the same time a cryogen is applied to the welding zone in the form of two jets 6, 7 which pass respectively through nozzles 8, 9.

The cryogen may be a liquid cryogen for example liquid nitrogen or liquid argon. Alternatively the cryogen could be solid carbon dioxide or a mixture of solid carbon dioxide together with a liquid cryogen.

Referring now to Figure 2 where the two metal plates 11, 12 are to be fillet welded. Heat is applied to a welding zone via a torch 13 to provide sufficient heat for the welding process to take place. Simultaneously a cryogen is applied in the form of jets 15 to the general area of the welding zone via nozzles 16, 17, 18.

It has been found that by using a cryogen to cool the metallic components being welded the following effects have been observed:

a) the reduction or control the level of distortion;

b) the protection of heat sensitive components near the welding zone;

c) the reduction of the effects of chemical degradation as a result of heat; and

d) the control of metallurgical properties (ie control of grain growth).

The choice of the cryogen is dependent on the process and the material of the metallic plates being welded. The amount of cooling and location to which the cryogen is applied is strictly controlled in order to achieve the desired effect. This is achieved by applying the cryogen via a nozzle or nozzles directed on to the surface of the work pieces being welded. The size and geometry of the nozzles is a critical factor for controlling the cooling footprint as well as the location and orientation of the cooling jets. It is critical that the jets of cryogen do not interfere with the welding operation.

Example

When butt welding two aluminium alloy plates each 3mm thick, a cryogen of solid carbon dioxide was applied as a jet on the lower (root) side of the weld, trailing the welding point by approximately 20mm and at a stand off distance of 20mm. A 1mm diameter nozzle was used with a carbon dioxide consumption of approximately 1.5kg/min with a supply pressure of 22bar. This method was compared with tungsten inert gas (TIG) welding using a gaseous argon cooling flow of 40 litres/min.

Measuring the temperature at approximately 40mm from the weld line; with the argon gas cooling the temperature was 300°C. Whilst with the carbon dioxide cooling the temperature was only 100°C. The benefit of the lower temperature was the reduction in distortion in the order of 80% to 90%.

This method is applicable to various thermal welding processes, for example, Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW) laser welding and friction stir welding.

CLAIMS

1. A method of thermal welding together at least two metallic work pieces comprising the steps of applying heat at a welding zone for welding together the two work pieces, and applying at or adjacent the welding zone a cryogen in the form of at least one jet.

2. A method as claimed in Claim 1, in which the cryogen is a liquid cryogen.

3. A method as claimed in Claim 2, in which the liquid cryogen is nitrogen.

4. A method as claimed in Claim 2, in which the liquid cryogen is argon.

5. A method as claimed in Claim 1, in which the cryogen is solid carbon dioxide.

6. A method as claimed in Claim 1, in which the cryogen is a mixture of solid carbon dioxide and a liquid cryogen.

7. A method of thermal welding together at least two metallic work pieces substantially as hereinbefore described with reference to and as illustrated in the Figures of the accompanying drawings.

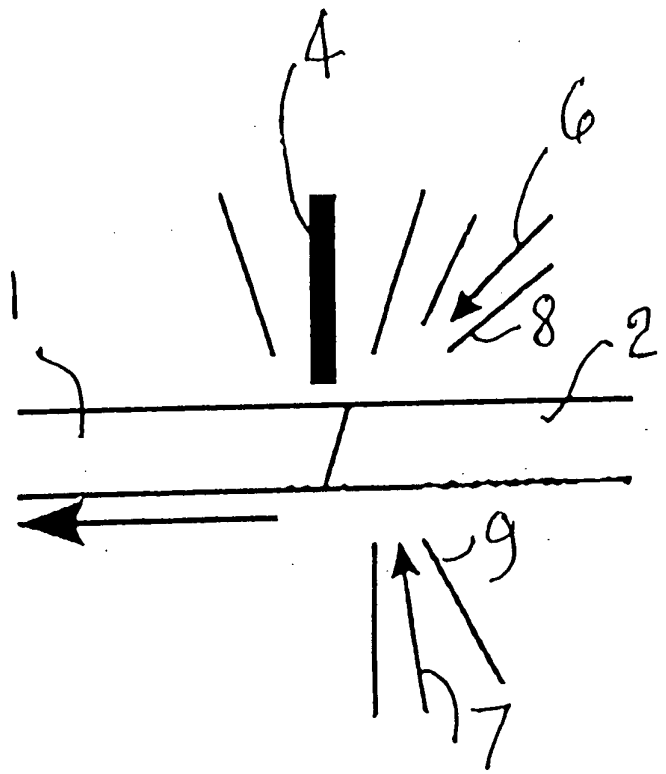


FIGURE 1

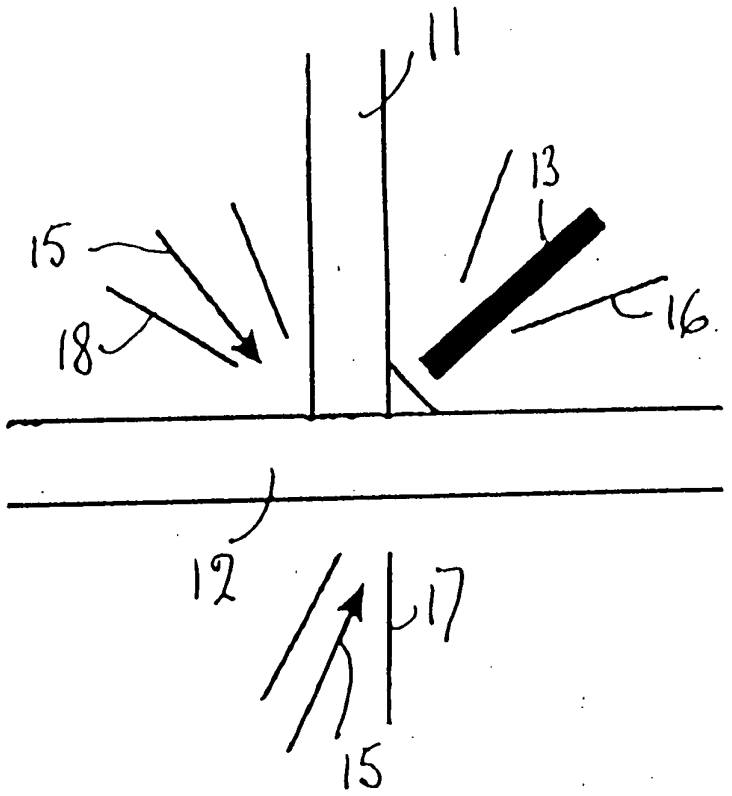


FIGURE 2